

Lower Passaic River: Geochemical Evaluation of Historical Sediment Data

Presentation to the PDT
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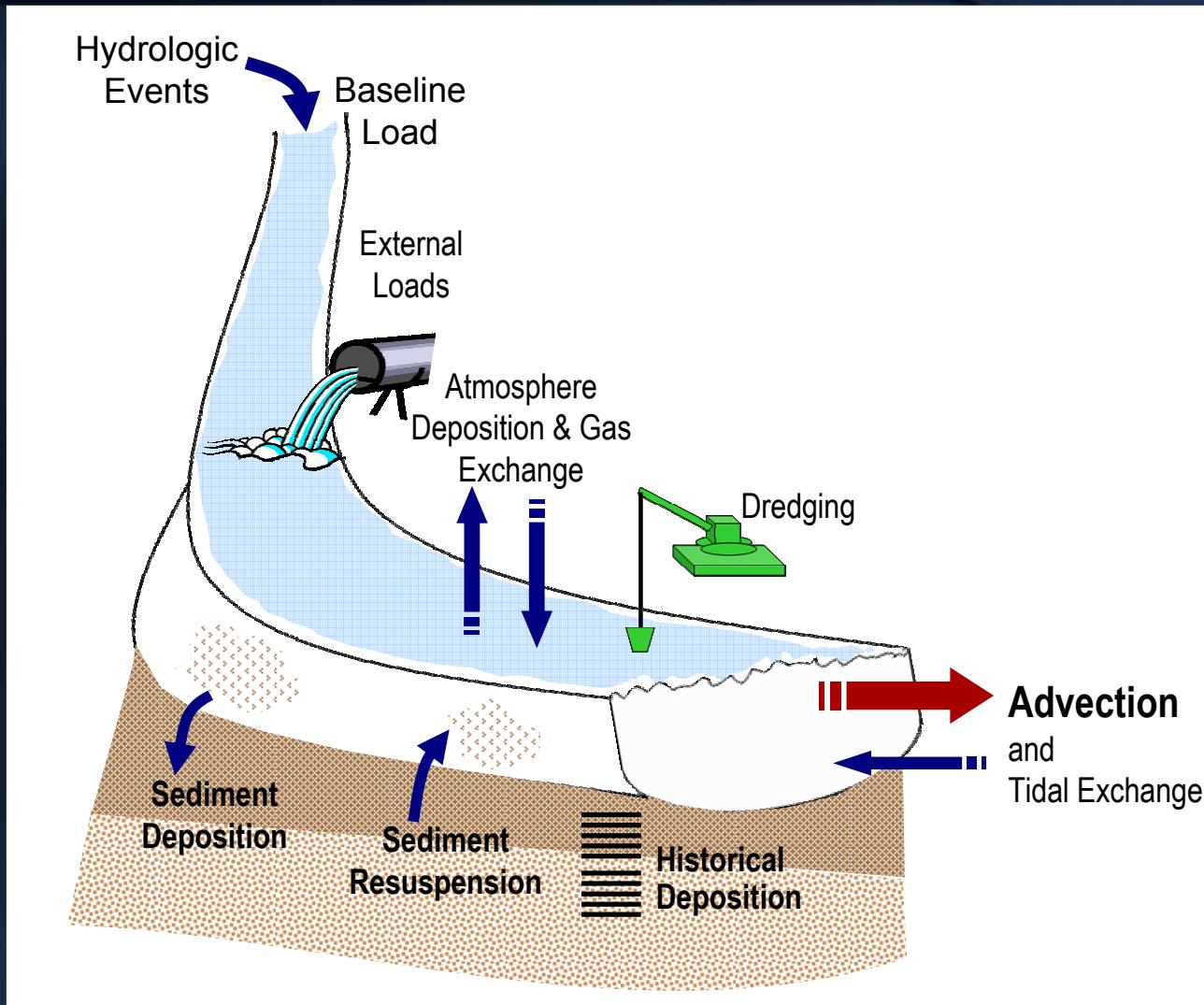
Outline

- Goals of the Initial Analysis
- Geochemical Framework
- Evidence for Sediment Deposition and Stability
- Contaminant Distributions
- Possible Evidence for External Sources
- Summary of Observations

Goals

- Obtain a greater understanding of the processes and loads that govern contamination in the Passaic
- Understand the distribution of contaminants as it relates to these processes

Geochemical Model Framework



Initial Objectives

- Develop components of a Conceptual Site Model
 - Examine sediment stability
 - Examine major contaminant distributions
- Guide future sampling locations

Sediment Deposition and Stability

Sediment Stability

Deposition Rate
Indicators
Cs-137 and Pb-210

Bathymetric
Change

Areas of
Deposition

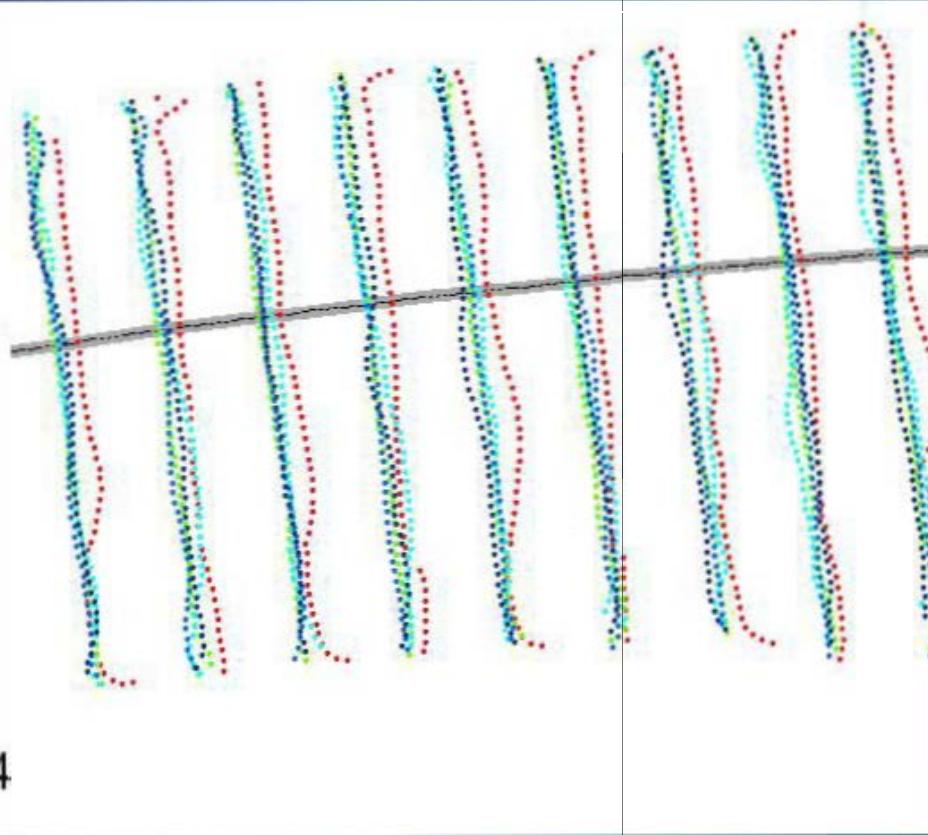
Areas of
Scour

Net Sedimentation

Bathymetric Survey Evaluation

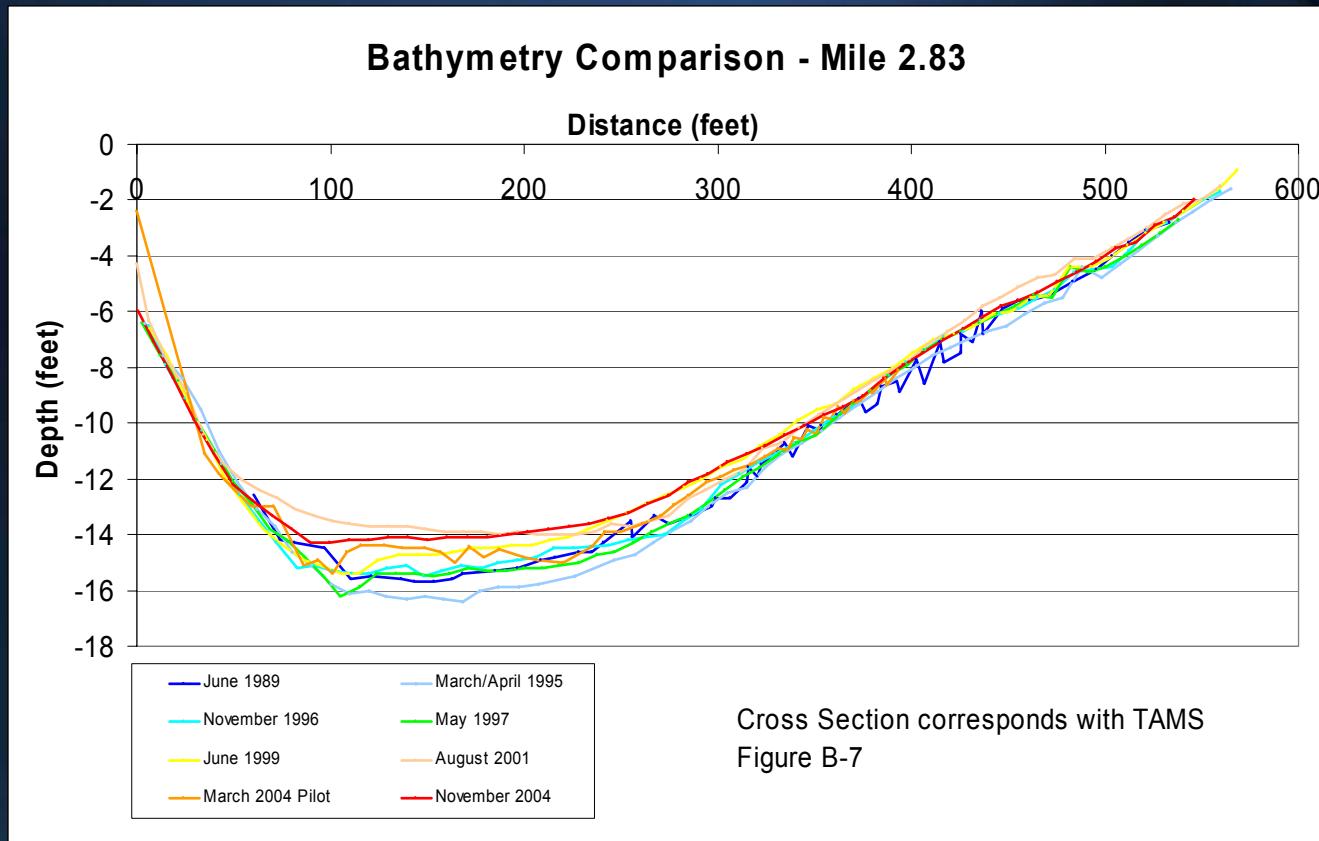
Legend

- 1995
- 1996
- 1997
- 1999
- 2001
- 1989
- March 2004
- November 2004

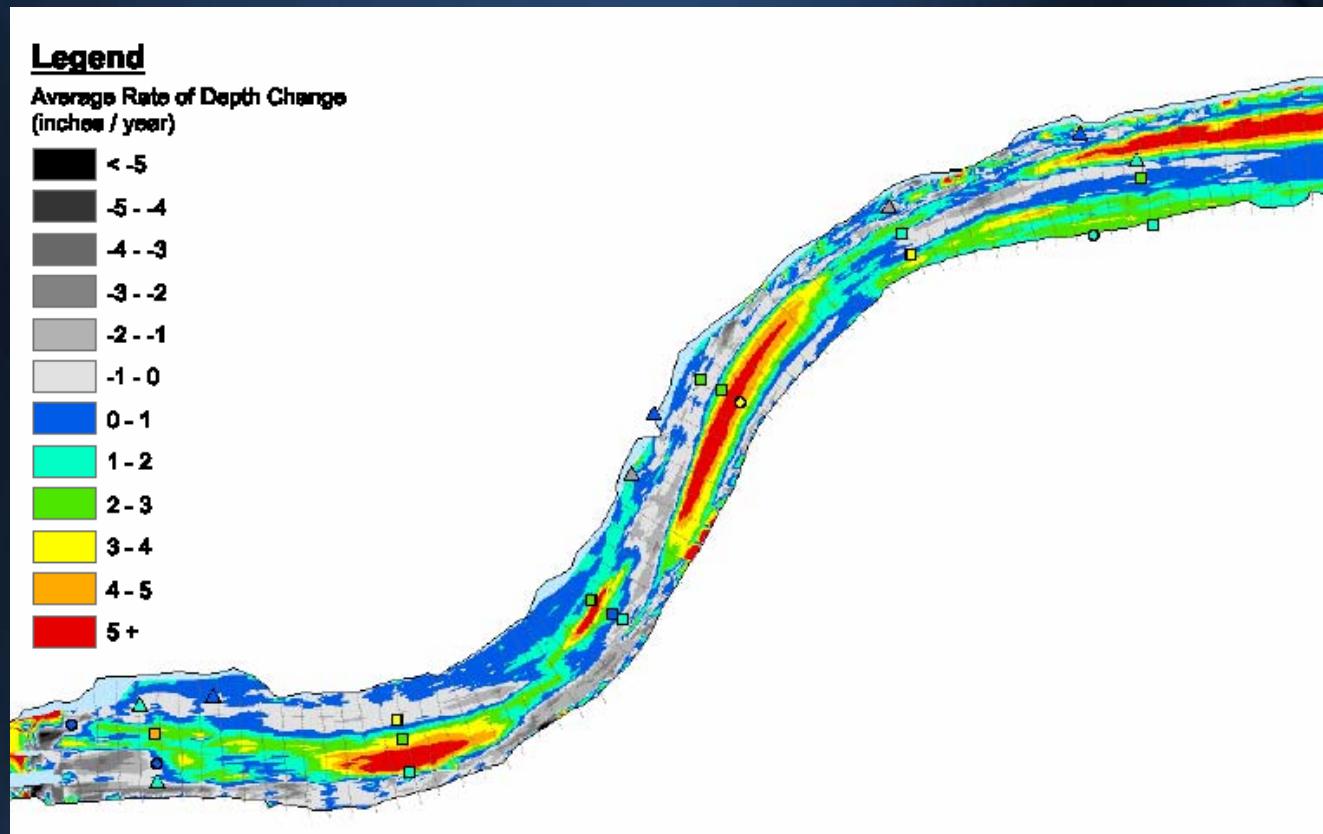


Best Spatial Alignment is for 1995-2001
Transects

Bathymetric Comparison: RM 2.83



Bathymetric Variation Map



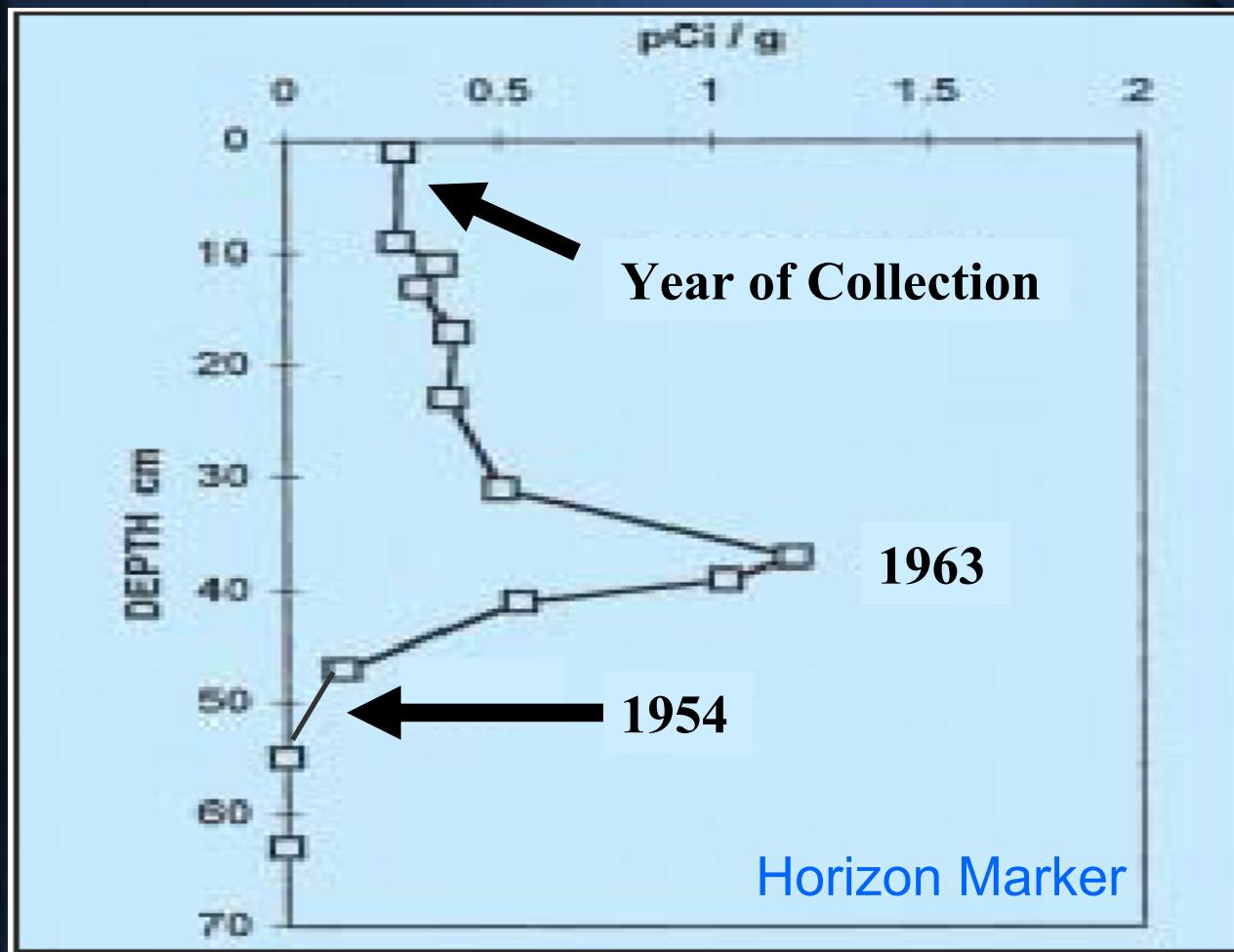
1995 vs. 2001

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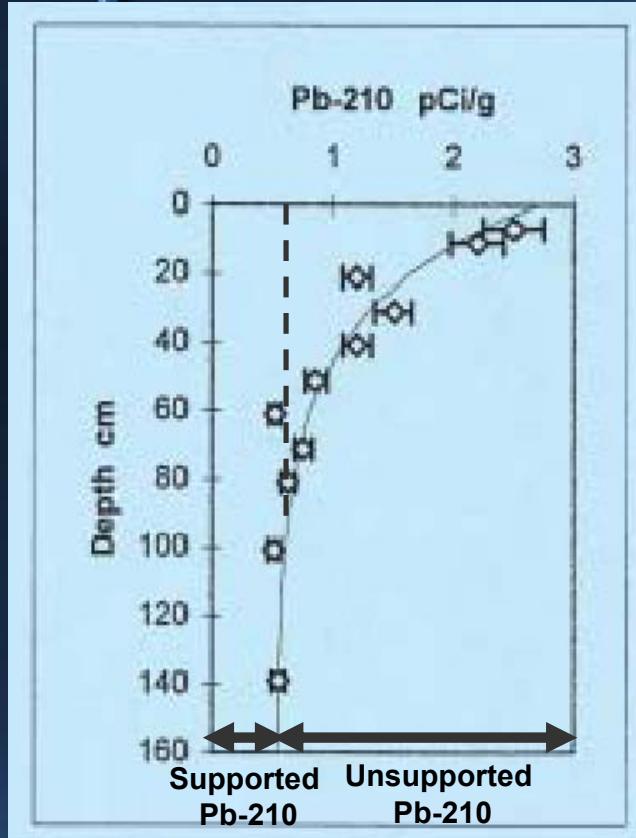
Radionuclide Analysis

- Cs-137 and Pb-210 (as Po-210) exist for nearly 100 cores collected in 1995
- Core profiles reflect a range of conditions from rapid deposition to the absence of sedimentation
- Cs-137 and Pb-210 yield similar rates of accumulation within a core

Ideal Cs-137 Profile

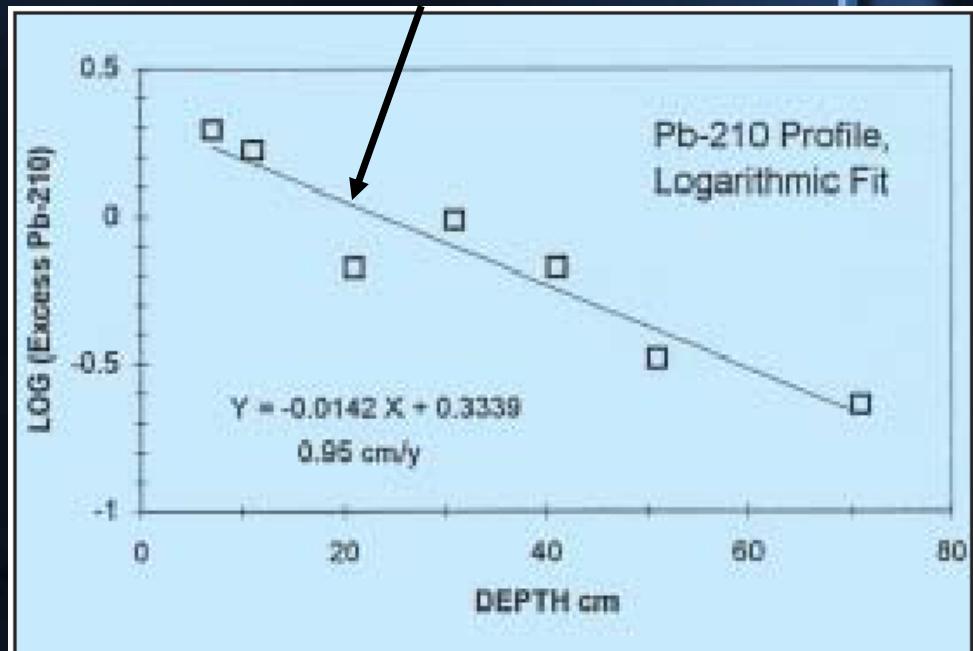


Ideal Pb-210 Profile

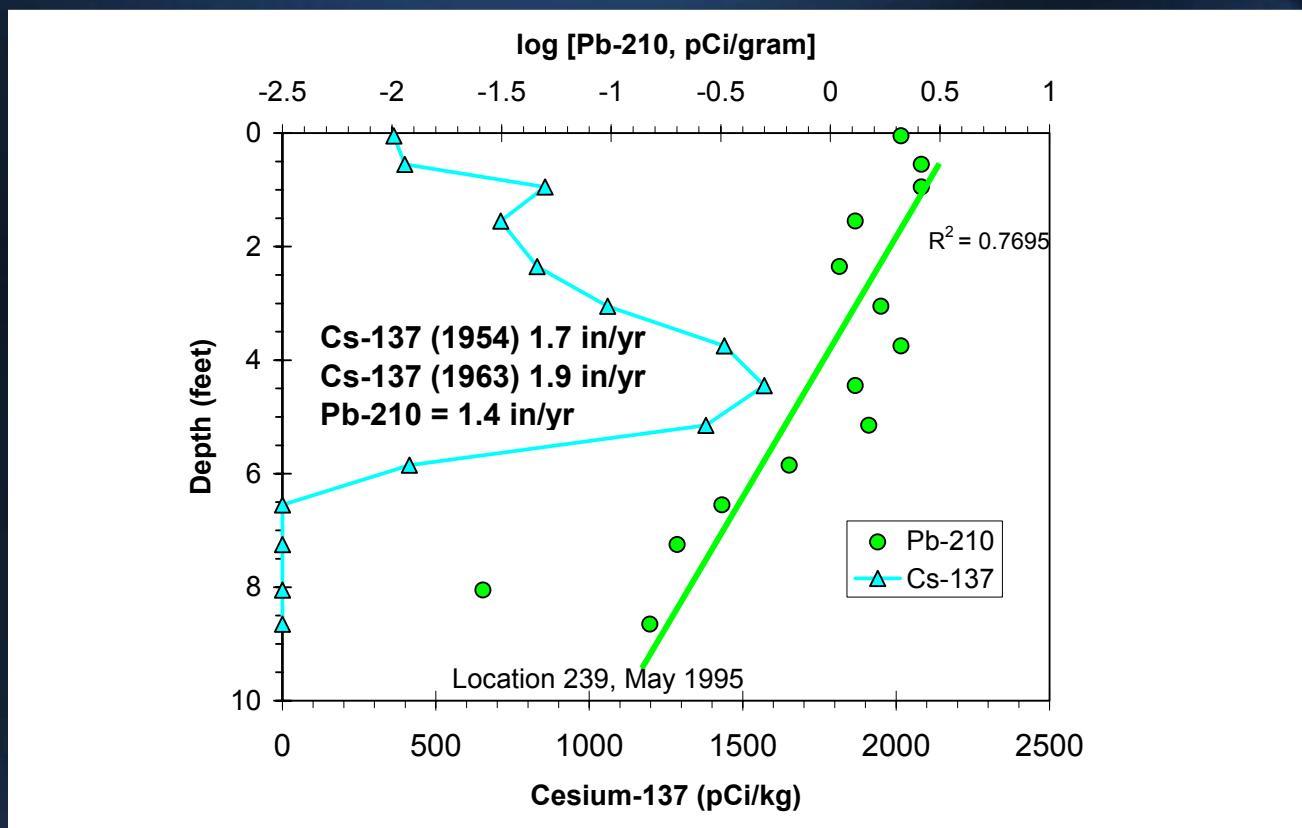


Sediment “Clock”

Slope of line yields
rate of deposition

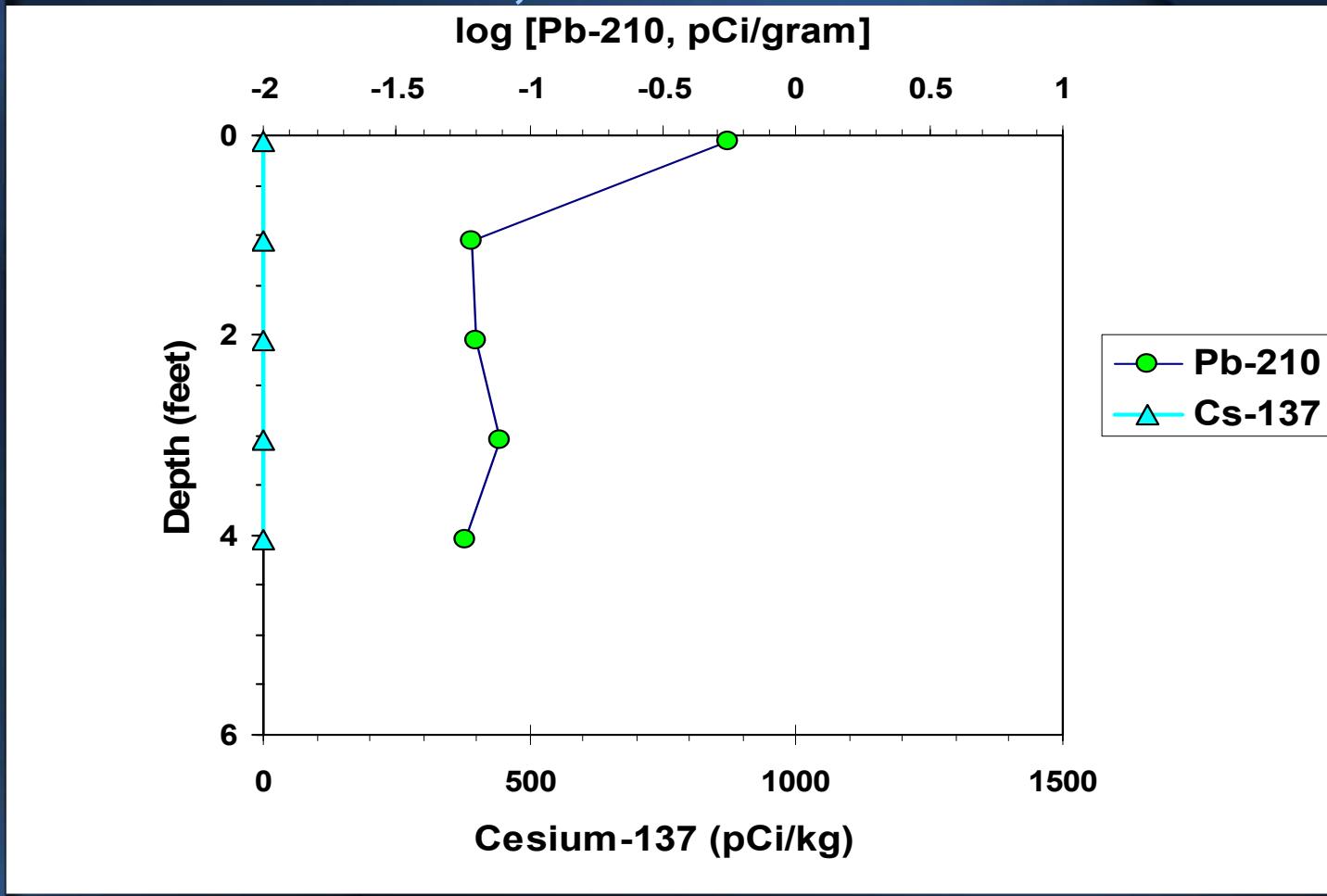


Depositional Site Location 239, 1995:



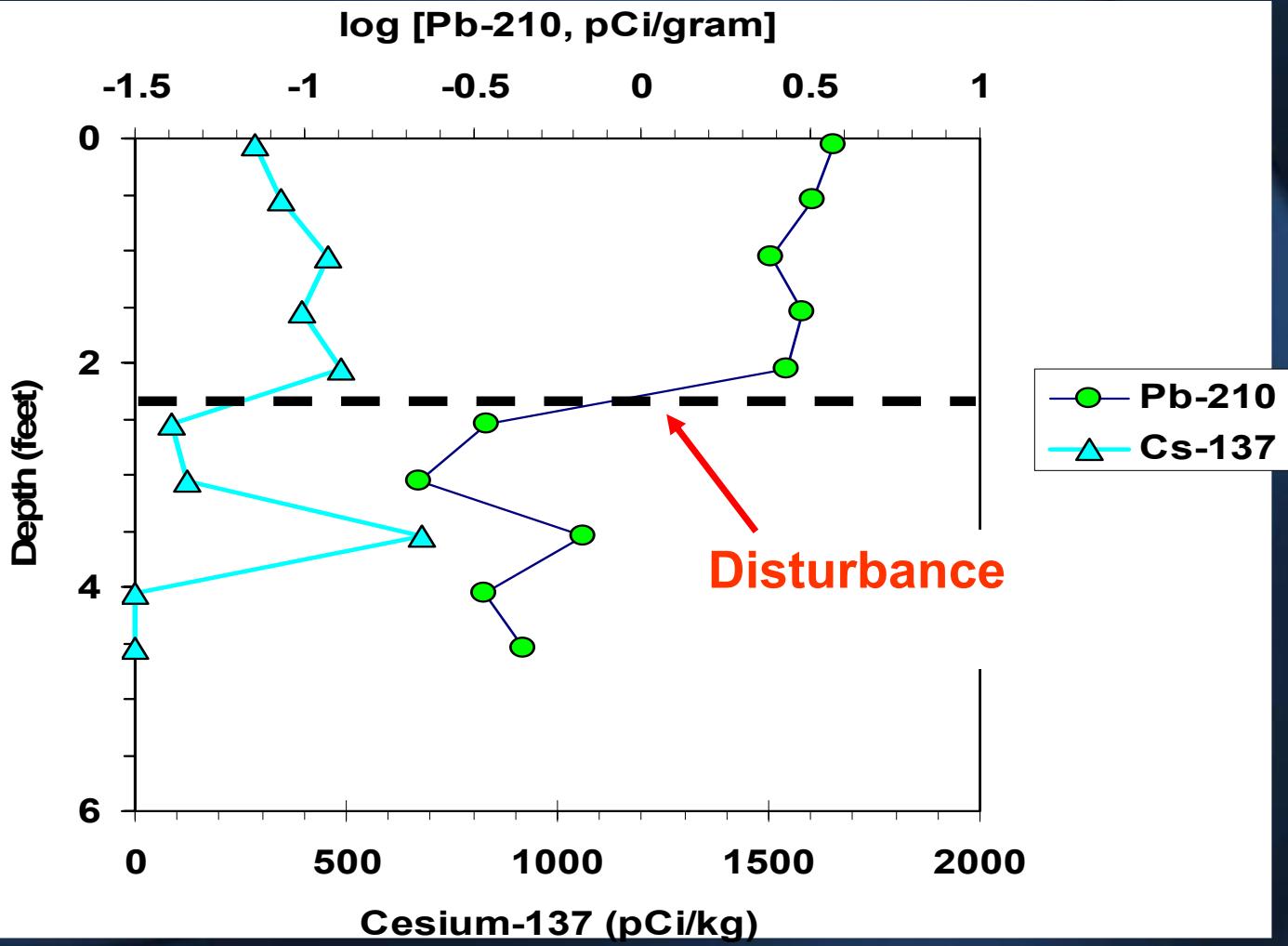
Non-depositional Site

Location 189, 1995: RM 4.47



Disturbed Site

Location 206, 1995: RM 4.5



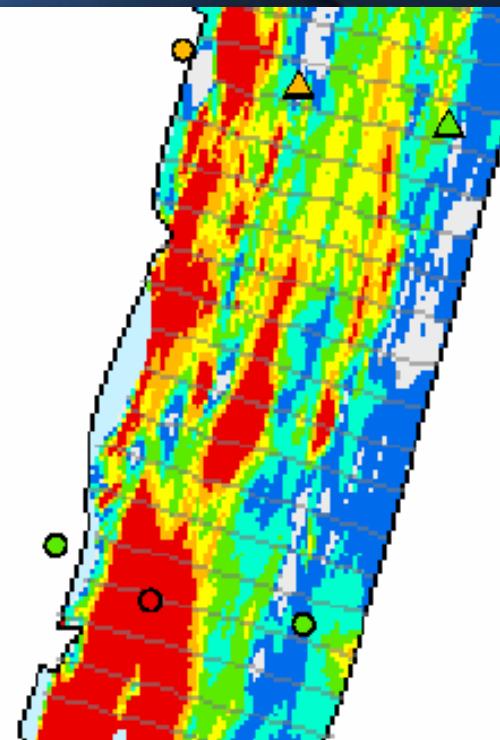
Comparing Bathymetry and Radionuclide Analyses

Change in
Bathymetric
Surface was
converted to a
Sedimentation
rate for areas
with Deposition

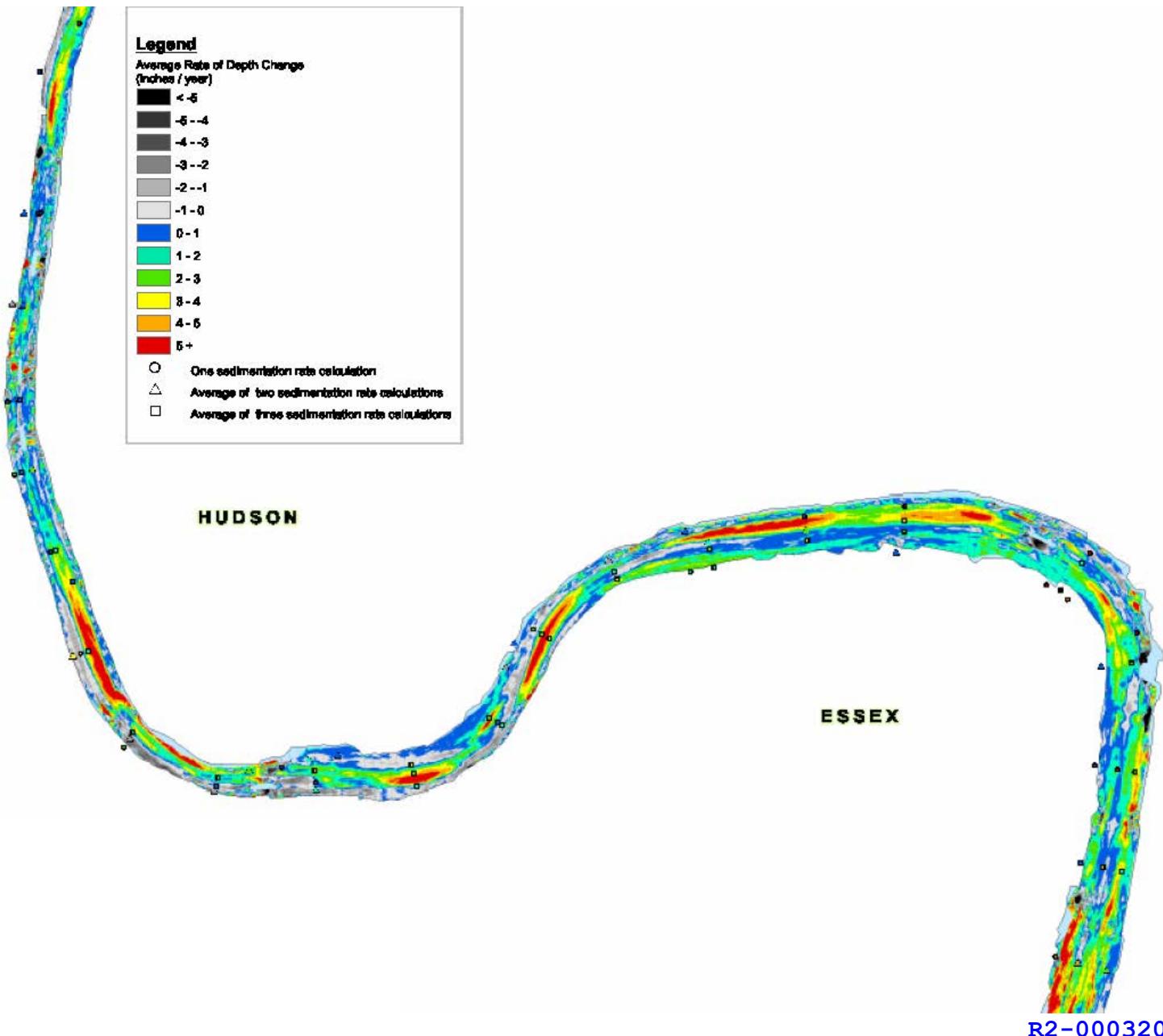
Legend

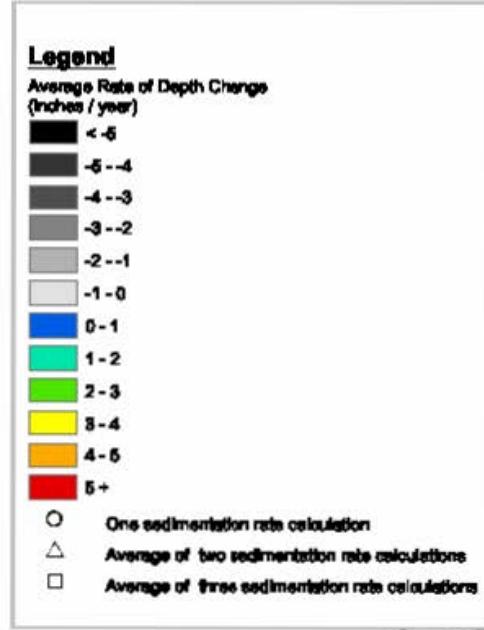
Average Sedimentation Rate
(inches / year)

Scour / No Deposition
0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
> 5
○ One sedimentation rate calculation
△ Average of two sedimentation rate calculations
□ Average of three sedimentation rate calculations



Bathymetric Comparisons





HUDSON

ESSEX

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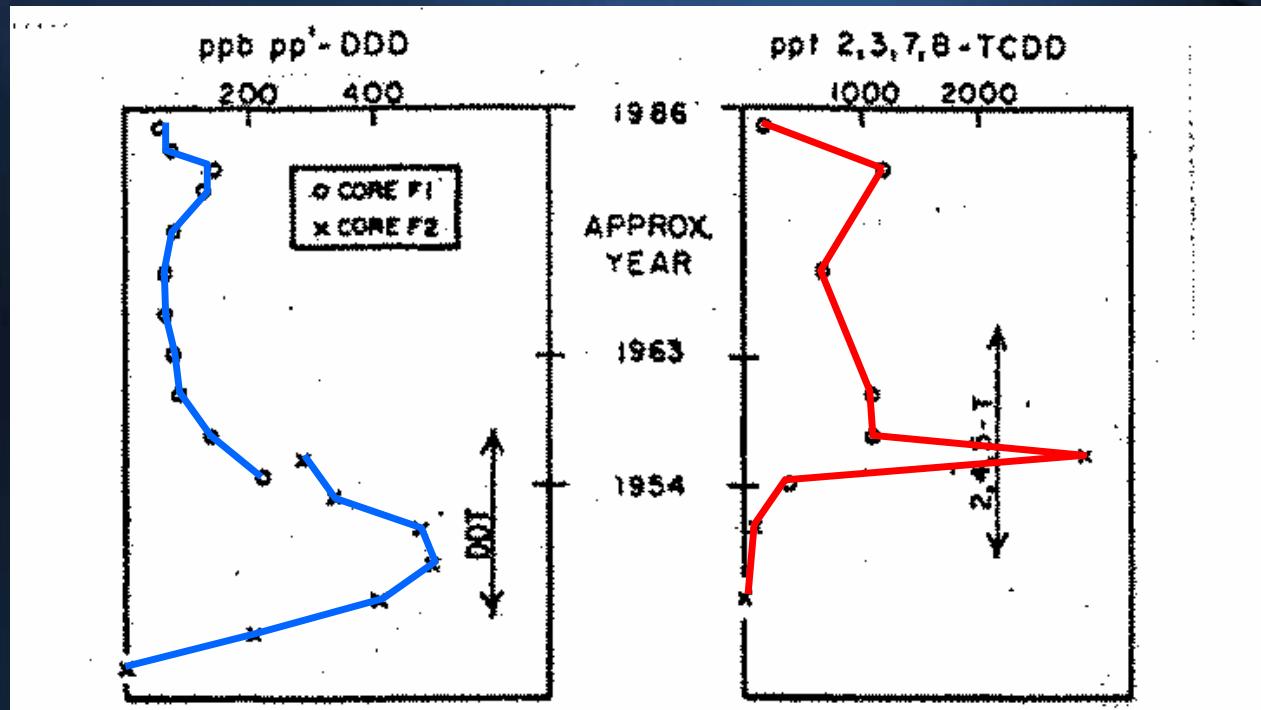
Contaminant Analysis

- DDT
- Dioxins (2,3,7,8-TCDD)
- Mercury
- PAHs

2,3,7,8-TCDD and DDT

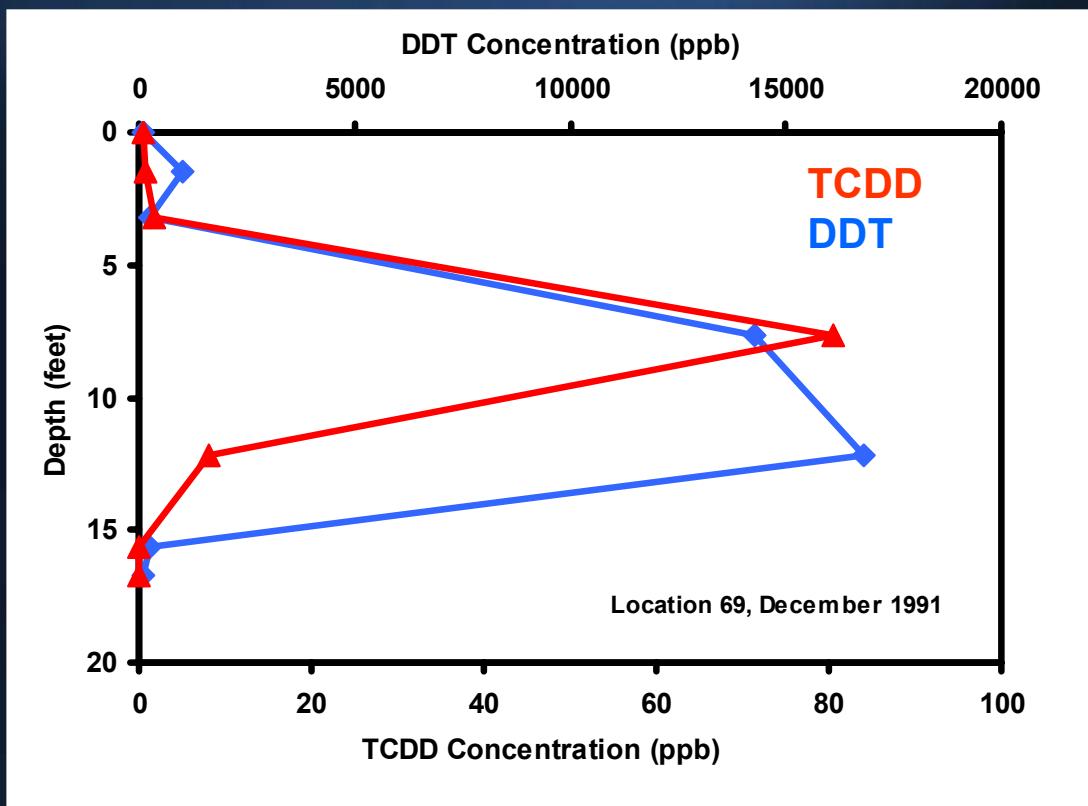
History of Contamination

Bopp et al. (1991) - Newark Bay Core F



DDT predates 2,3,7,8-TCDD

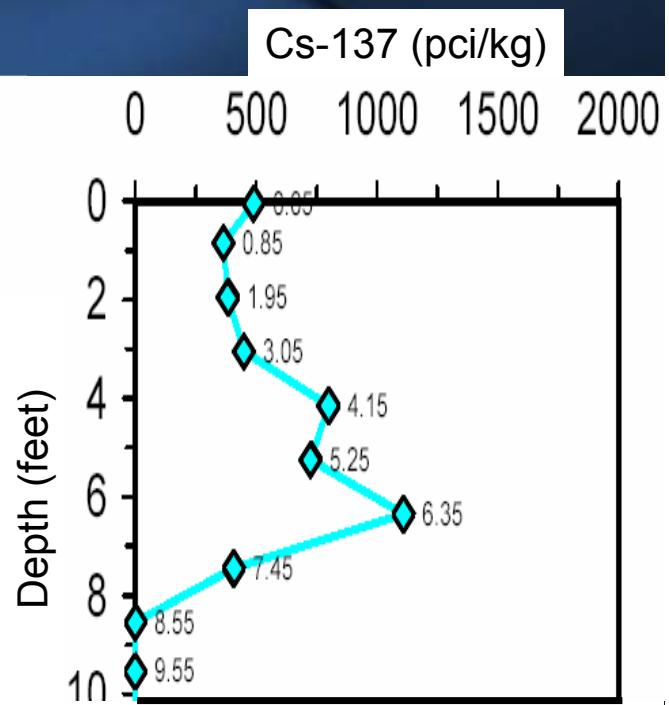
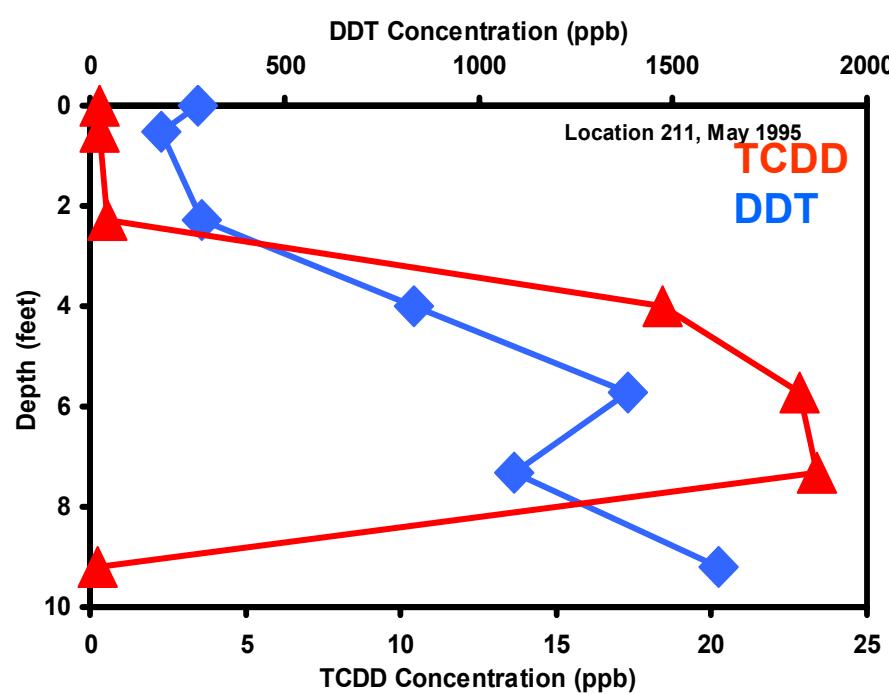
Deep Passaic Cores Are Consistent with Bopp's Observations in the Passaic



1991 Core, RM 3.5

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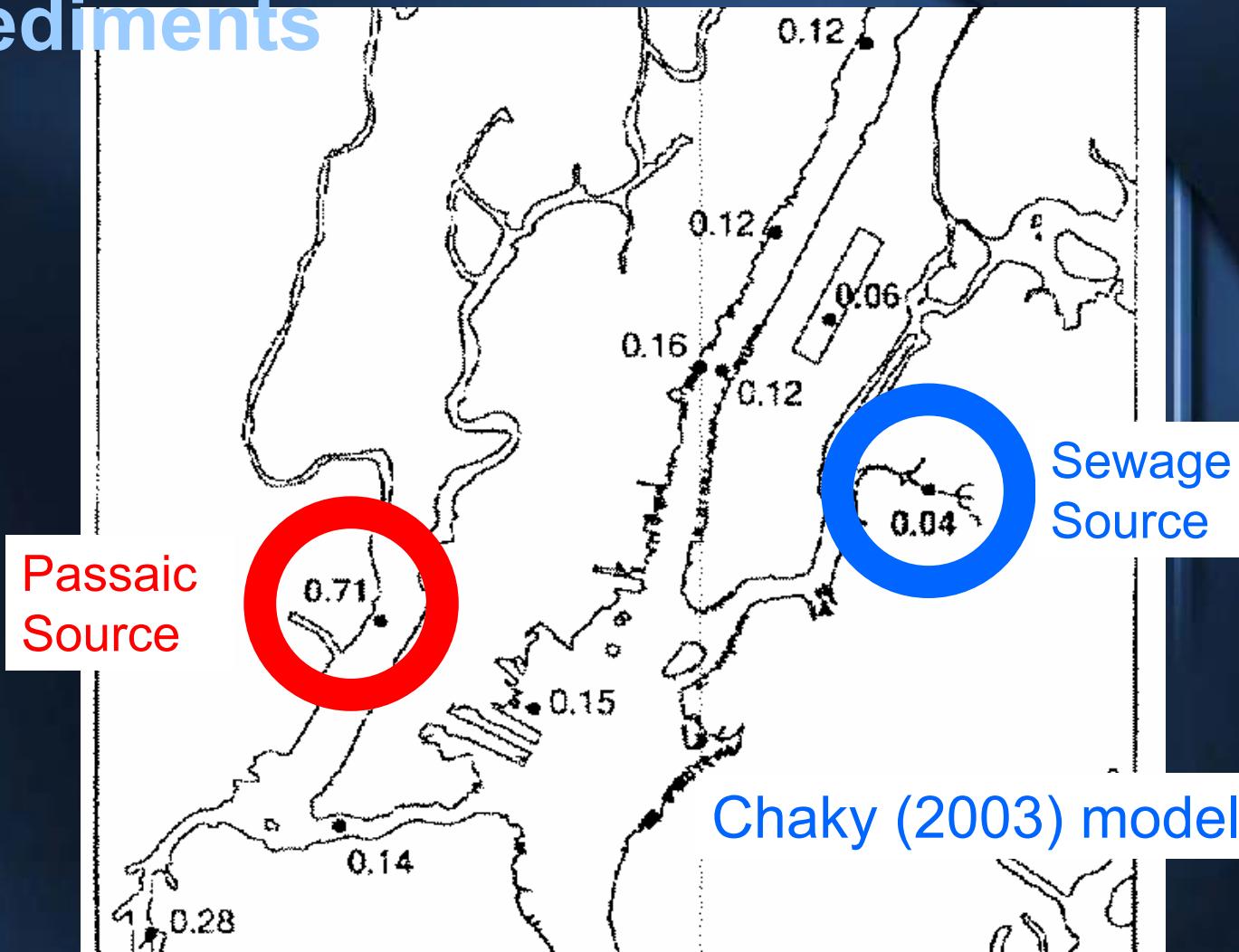
Shallow cores are consistent with this history



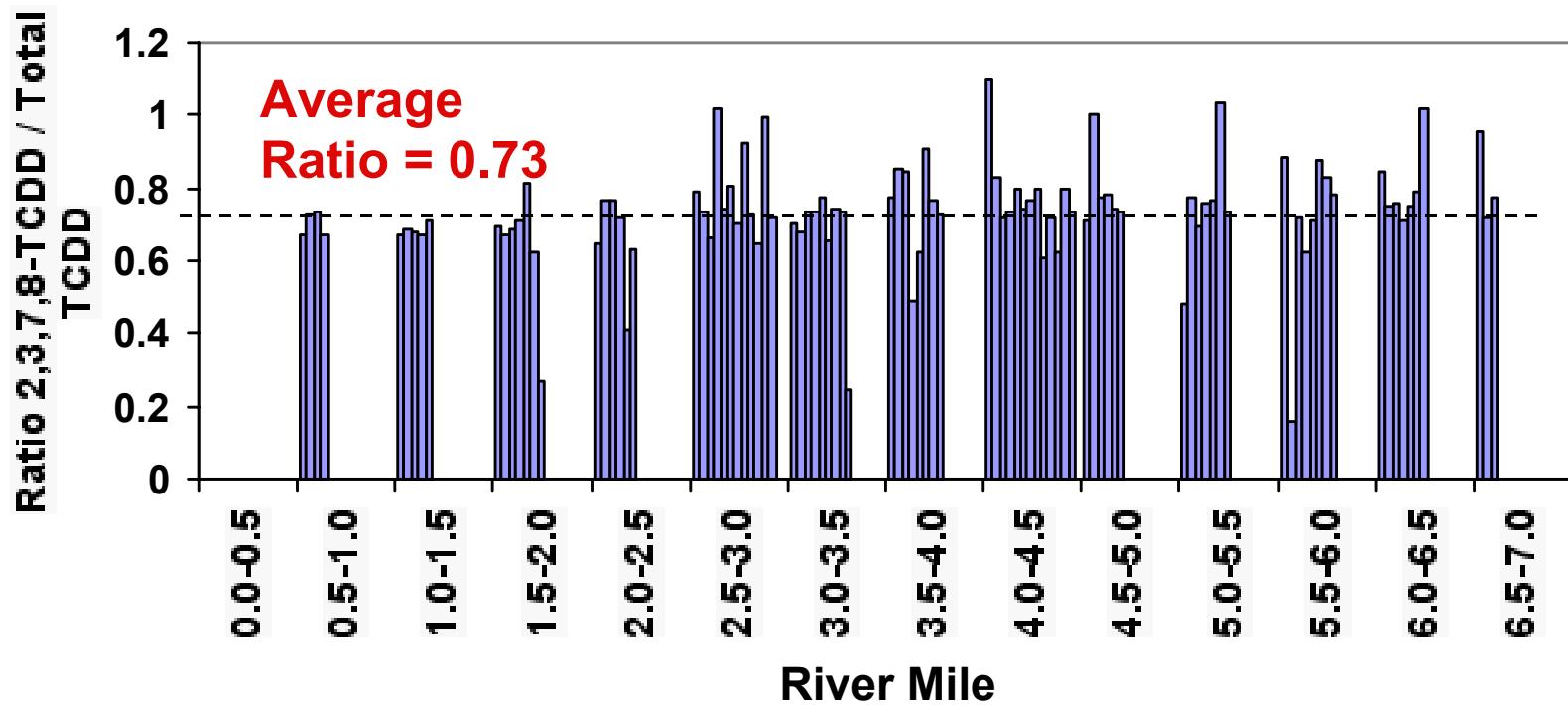
1995 Core, RM 3.78

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2,3,7,8-TCDD/Total TCDD in Harbor Sediments

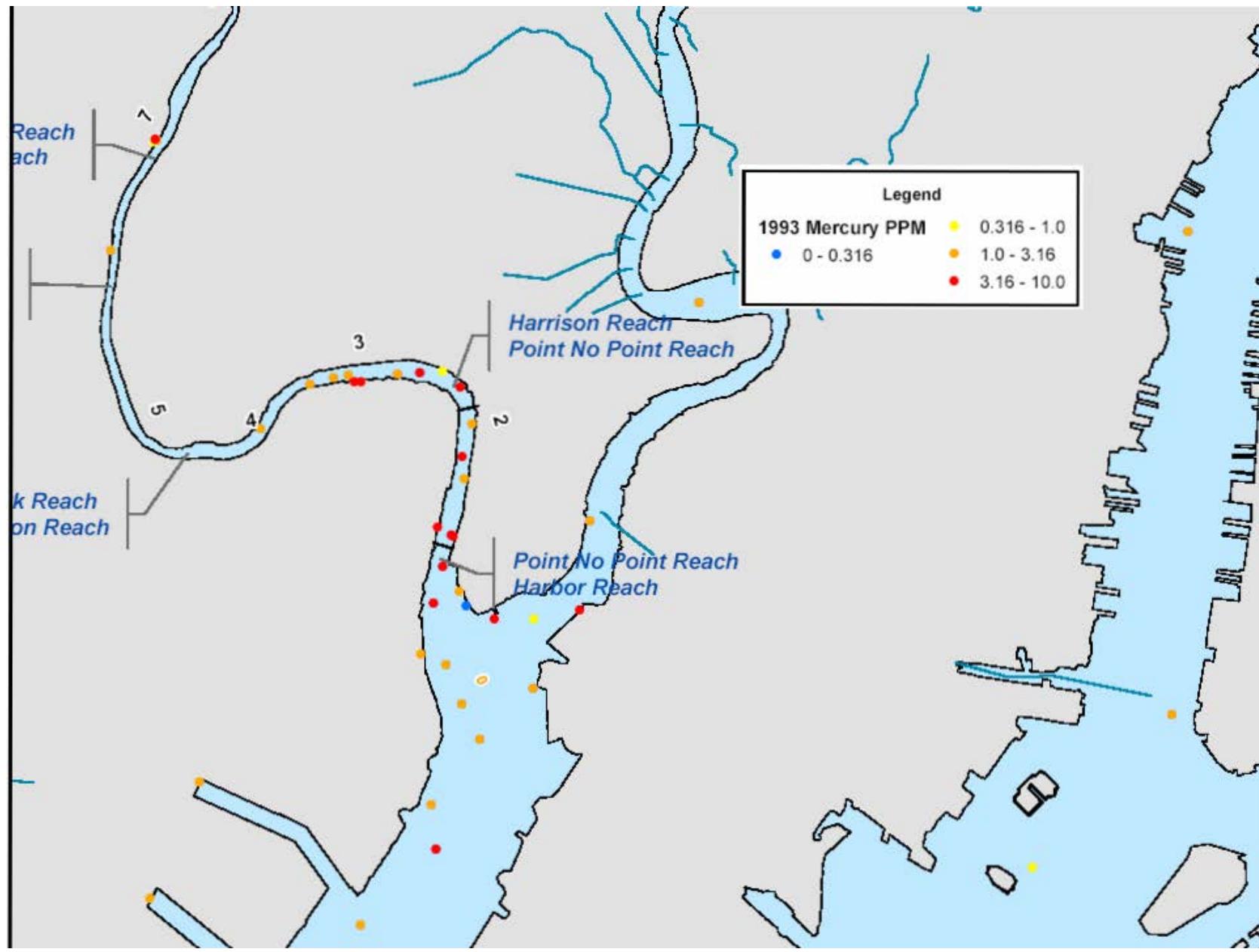


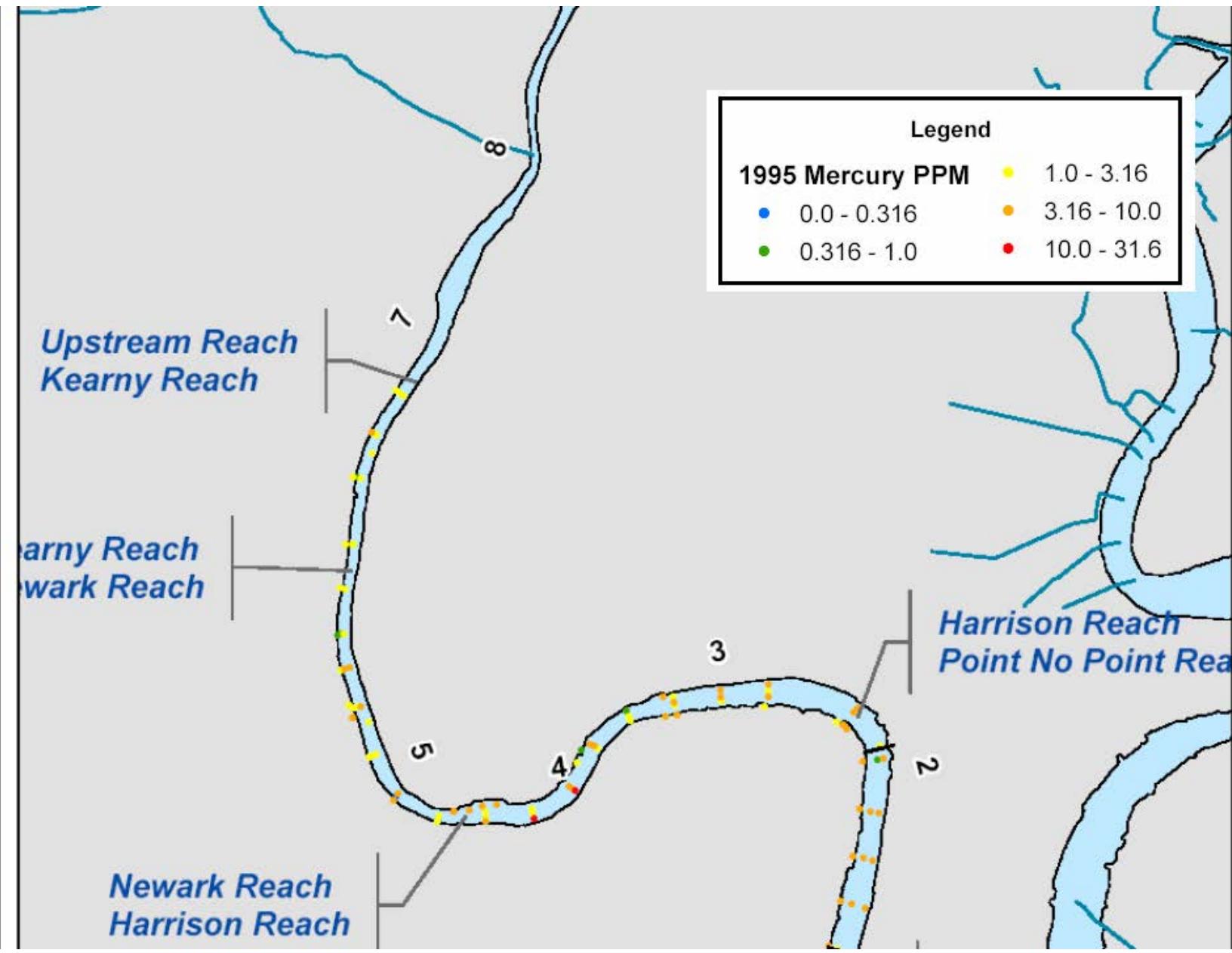
Passaic River Surface Sediments Have the TCDD Source Ratio



Mercury

R2-0003209

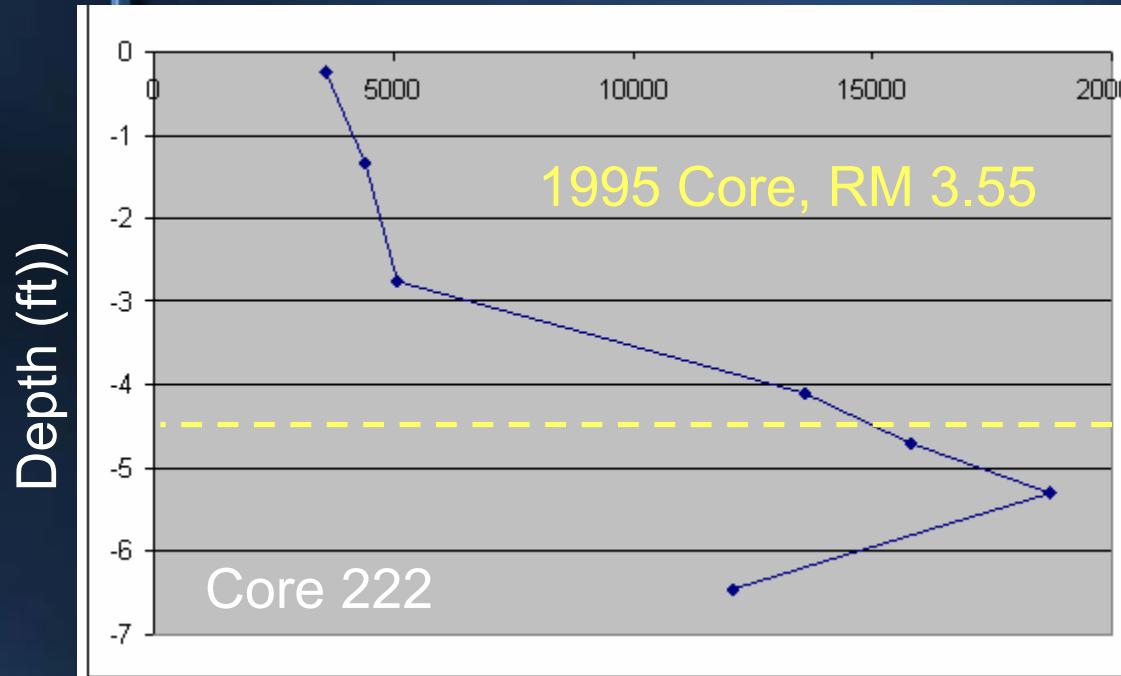




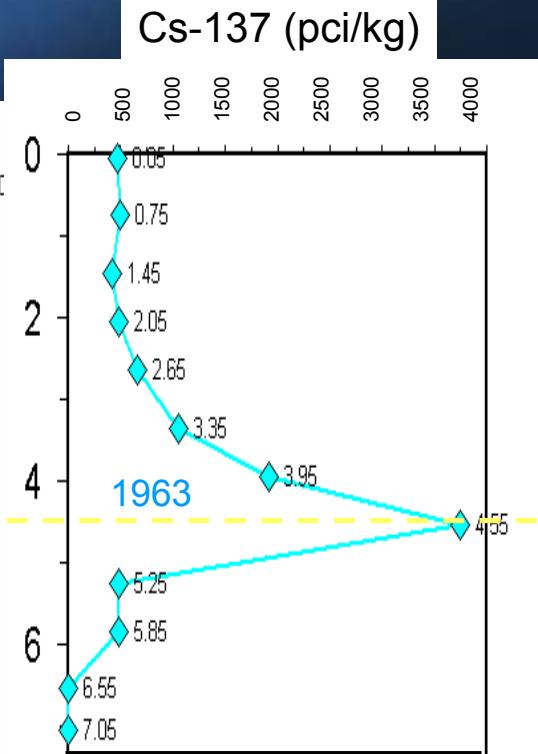
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Mercury Depositional History

Hg (ug/kg)



Cs-137 (pci/kg)

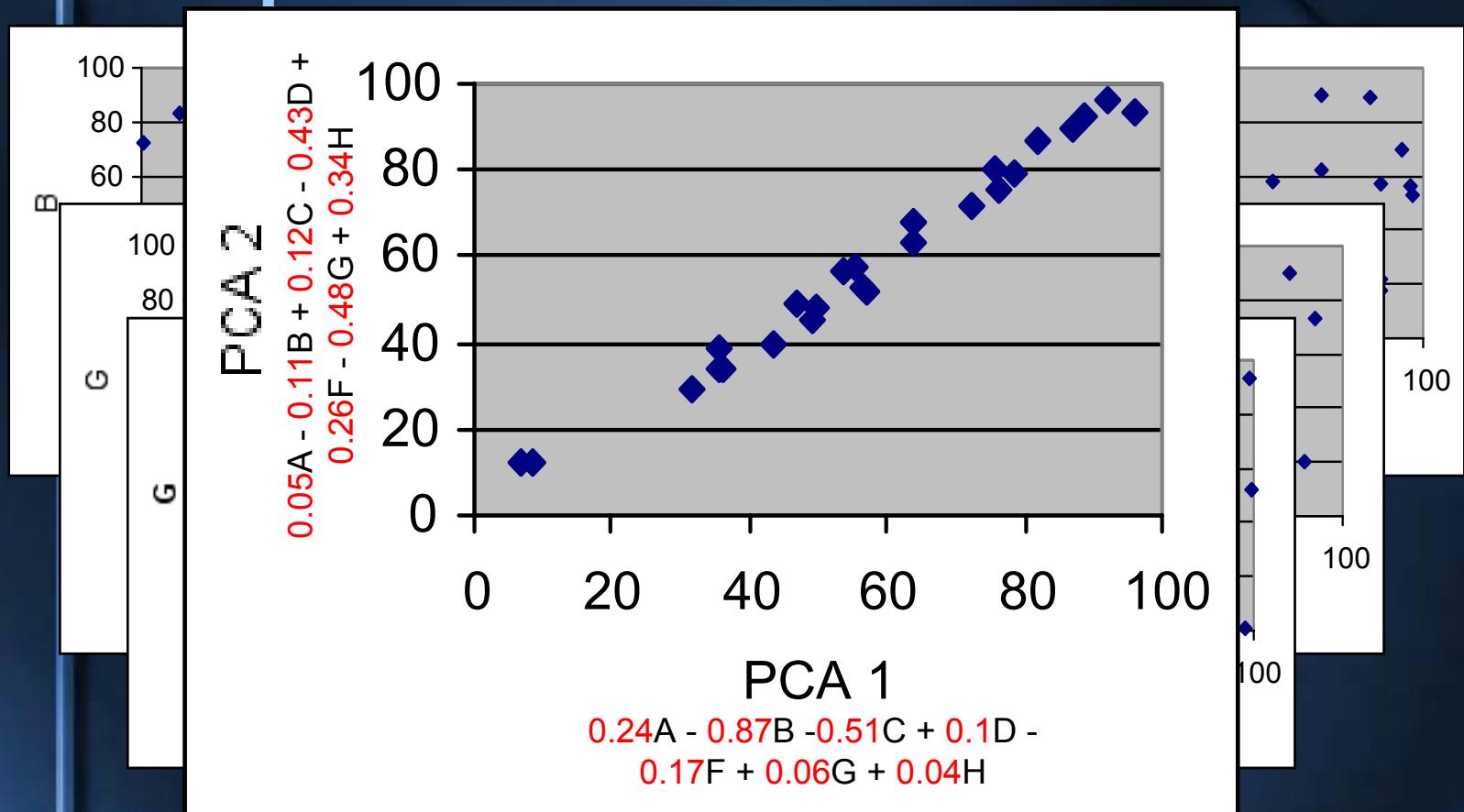


- Hg maximum discharge occurs in early 1960s.
- Surface concentrations remain elevated.
- Significant inventory at depth.

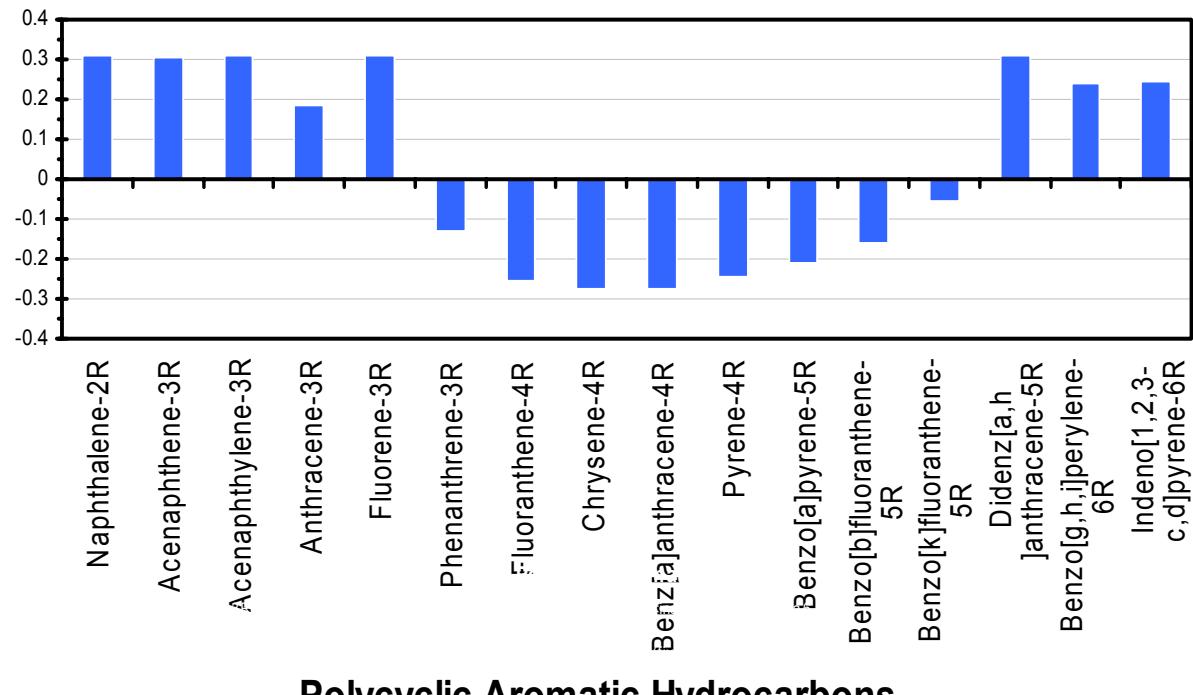
PAHs

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What Are Principal Components?

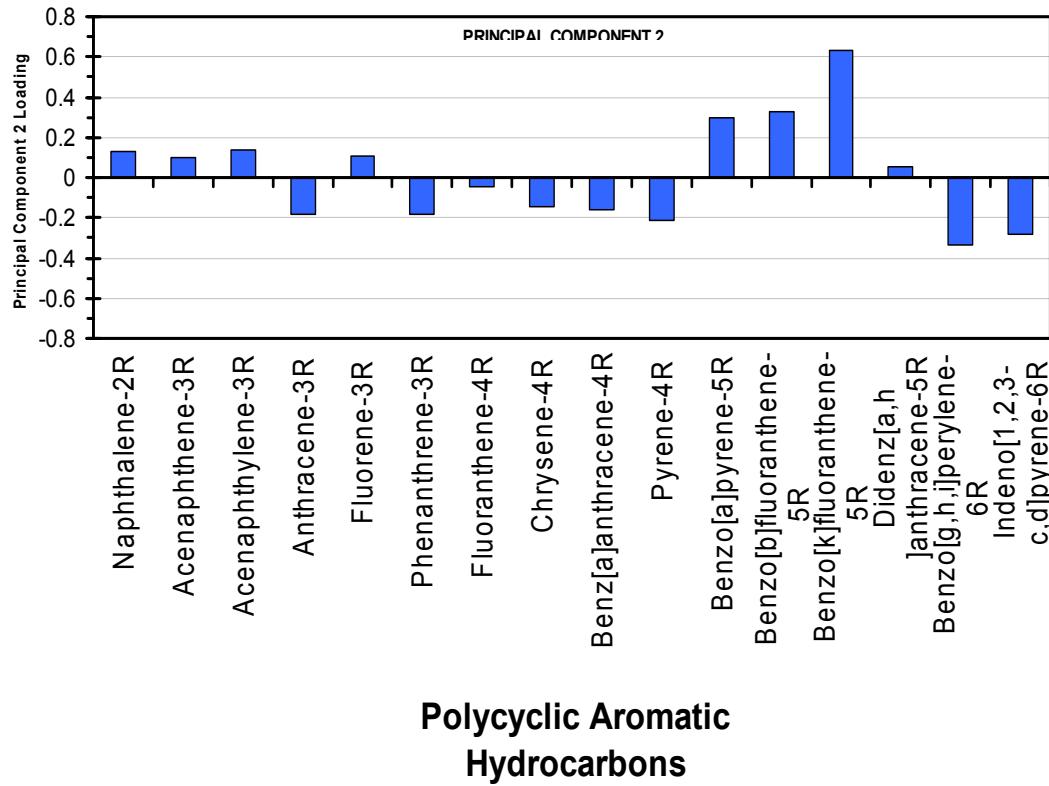


Principal Components Analysis for PAHs

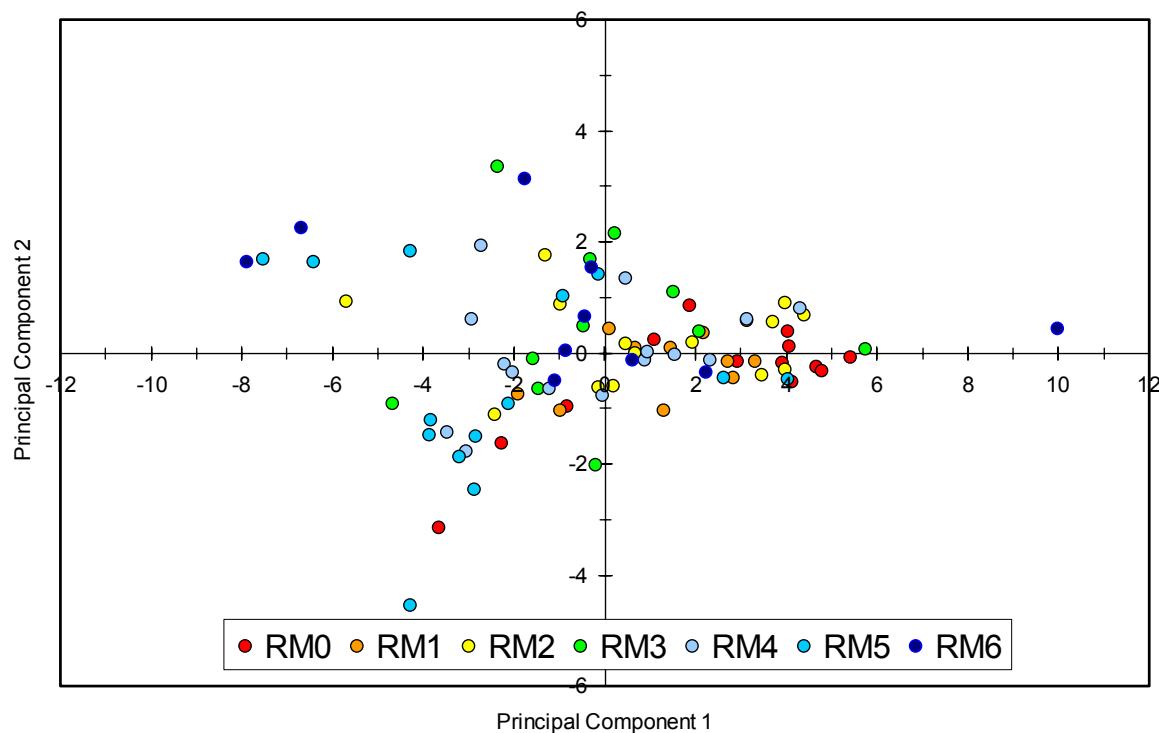


First component clearly linked to molecular structure

Second Component Less Useful



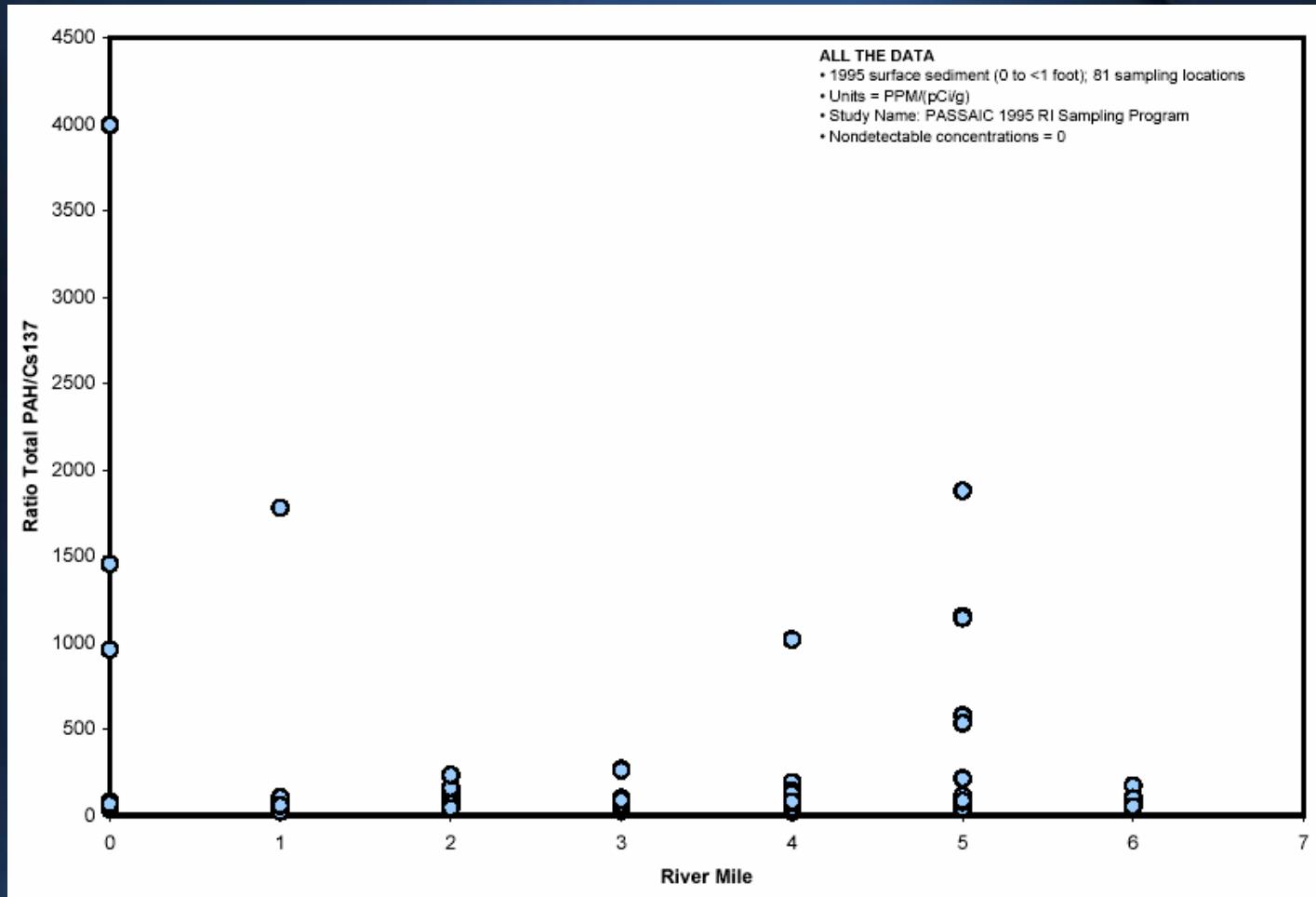
PAH Pattern Correlates with River Mile



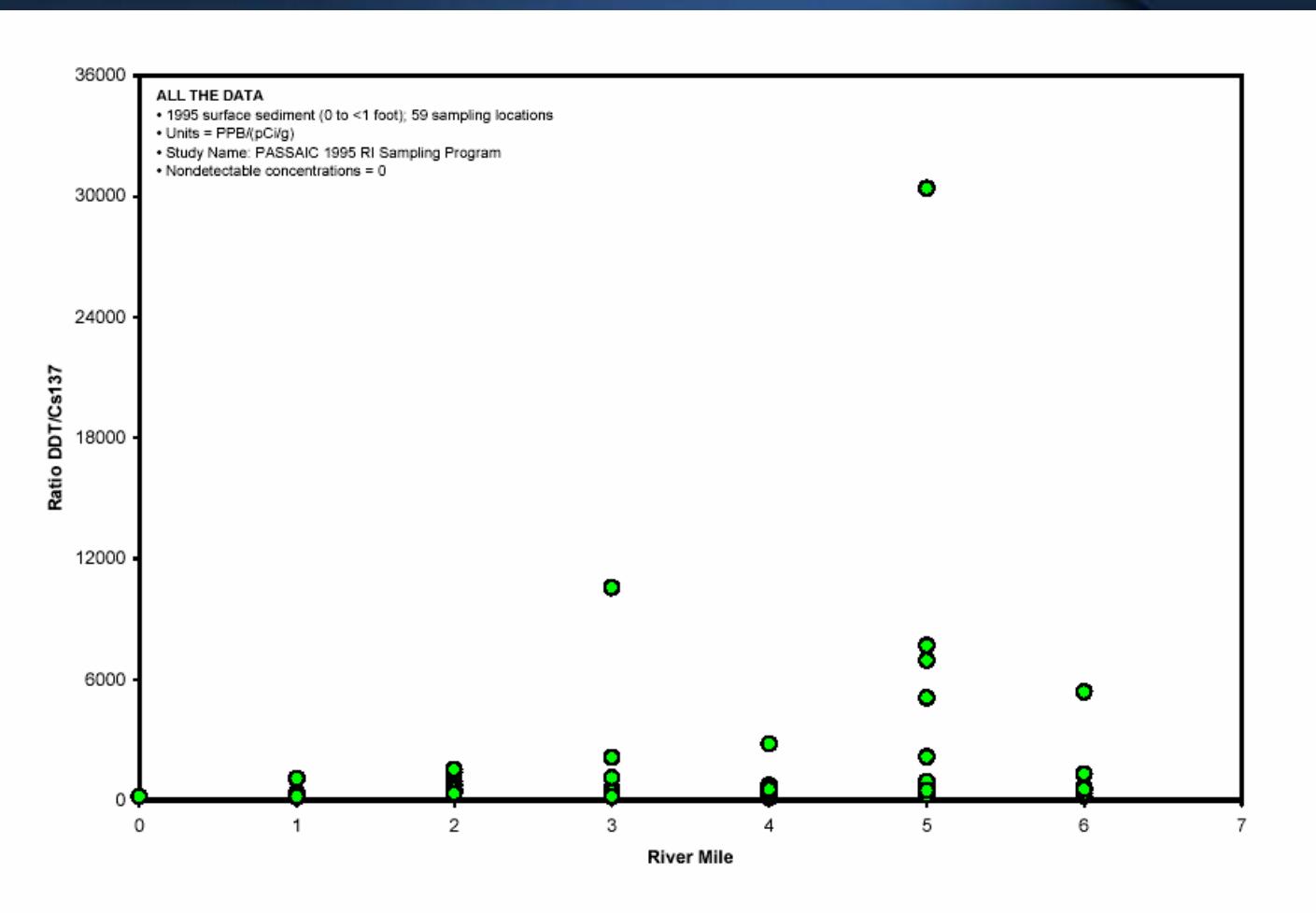
Evidence for External Source(s)

- Ratio of contaminant to Cs-137 can be used to identify external source regions
- Analysis is based on homogeneity of Cs-137 in fine-grained sediments in a given year
- Particle-reactive contaminants will follow Cs-137 dispersion through estuary
- Proximity to source will appear as increase in ratio to Cs-137 since local deposition will accumulate high contaminant levels before dispersion can dilute the impact
- Erosion of older sediments can also cause a ratio change

PAHs vs Cs-137



DDT vs Cs-137



Initial Observations (1)

- A heterogeneous depositional environment exists in the lower 7 miles of the Passaic River.
- This heterogeneity suggests depositional, erosional, and dredging events throughout the river.
- Bathymetric measurements of sedimentation rate appear to coincide with radionuclide measurements of sedimentation rates.

Initial Observations (2)

- The geochronology of a sediment core is a useful tool for understanding sediment transport and the extent of contamination.
 - Radionuclides may be used to establish the depth of contamination
- DDT is well correlated with dioxins and may serve as a surrogate for contaminant delineation and in fate and transport.

Initial Observations (3)

- 2,3,7,8-TCDD/Total TCDD is diagnostic of the Passaic source, suggesting the absence of other significant sources.
- Mercury contamination is extensive and suggests local sources
- Evidence for sediment transport to Newark Bay from radionuclide and chemical contaminant data. Results consistent with Bopp et al. (1991) and Chaky (2003).

Initial Observations (4)

- Cs-137 results suggest source areas near RM 5 and 1
- PAH patterns suggest at least 2 PAH sources
- Strong surface concentration gradients suggest minimal sediment transport upstream from Newark Bay

Acknowledgements

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